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FIBROUS ROOT ROT AND FOOT ROT OF CITRUS

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Fibrous root rot and foot rot caused by Phytophthora spp. continue to be primary factors in poor growth and death of citrus trees of all ages both in the nursery and in the field (2,8,9). The term foot rot is used synonymously with brown rot gummosis and collar rot (1,14). Foot rot is considered distinct from another type of damage caused by the same fungi on fibrous feeder roots (13).

ROOT ROT SYMPTOMS. Root rot is a decay and a destruction of fibrous feeder roots. The epidermis on rootlets may slough or may easily slip off the stele under slight finger pressure.

FOOT ROT SYMPTOMS. Foot rot is a diseased bark condition on the lower trunk or crown roots of citrus trees after invasion near ground level by Phytophthora spp. (13). Phytophthora will not grow systemically from infected feeder roots beneath the soil into the trunk to cause foot rot. Zoospores must be splashed from the soil surface onto an infection site which usually is a wound less than 10 days old (5). Invasion of stems by Phytophthora spp. initially causes a yellowish-brown discoloration of tissues in the inner bark and cambium. This infection may remain localized and may not be visible externally. When the infection is more extensive, bark tissues crack, disintegrate and exhibit gummosis (Fig. 1). Above ground, small or large amounts of gum exude, depending on citrus variety and weather. Below ground, gum is less noticeable, since it is usually absorbed by water in the soil.

Fig. 1. Foot rot of citrus caused by Phytophthora parasitica. (DPI Photo No. 702994-8).

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CAUSAL AGENTS. Two common species of Phytophthora are known to cause root rot and foot rot of citrus. Their relative importance is dictated by temperature and/or geographic location; P. citrophthora (R. E. Smith and E. H. Smith) Leon is typically the predominant causal agent at lower temperatures while P. parasitica Dastur (syn. P. nicotianae B. de Haan var. parasitica [Dast.] Waterh.) predominates at higher temperatures (1). Phytophthora is a highly aerobic (requiring oxygen) microorganism. It grows well under conditions of high moisture, provided sufficient oxygen is present. It causes little damage under sustained anaerobic conditions when roots are submerged in stagnant water for an extended time. Under such conditions roots die primarily because of oxygen deficiency and toxic compounds produced by anaerobic bacteria (5). In New South Wales, P. citrophthora is the predominant species and one of the most destructive pathogens of citrus (1). In Queensland, P. parasitica is the predominant species (1). In California, both P. citrophthora and P. parasitica occur (8,9). Phytophthora syringae Kleb. and P. hibernalis Carne have also been found causing root rot and foot rot of citrus in California (10, p. 9-10). In Florida, P. parasitica is commonly isolated from infected roots and from foot rot lesions (6,13). Phytophthora citrophthora has a limited distribution in Florida and has caused brown rot of fruit (12) but has not been reported as causing root rot or foot rot.

CONTROL. Citrus root rot can be reduced by lowering soil pH (4, p. 192). The severity of Phytophthora root rot of citrus decreases with NO_3 (nitrate) nitrogen and increases when NH_4 (ammoniacal) forms are used (4, p. 190). High potassium in combination with low calcium increases disease caused by P. parasitica on citrus (4, p. 191).

Infested planting sites and areas to be used for nurseries may be fumigated with one of the recommended chemicals such as methyl bromide to assure at least temporary absence of these fungus root parasites and to give plants an unhampered start. However, in fumigated soils, Phytophthora may reinvade the soil and become an even more severe problem on citrus roots because fumigation often destroys soil microorganisms which compete with Phytophthora (5,11). For effective and safe use of agricultural chemicals for control of Phytophthora diseases in commercial citrus groves, consult the current "Florida Citrus Spray Guide" published by the Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville.

Seeds for the production of rootstock seedlings can be freed of Phytophthora by 4-10 minutes of immersion in well-agitated water at 120-125°F and coated with appropriate fungicides (5,8). This treatment is especially recommended for seeds from fallen fruit, does not impair germination, and assures the nurseryman that he will not contaminate his seed bed or nursery from the infested seeds.

The severity of attack by Phytophthora may be influenced by antagonism and competition from other microorganisms in the soil environment. One positive case of reduced disease severity was reported by Davis and Menge (3) who attributed tolerance to P. parasitica root rot in VA-mycorrhizal citrus seedlings infected with Glomus fasciculatus (Thaxter) Ger. & Trappe to the fact that mycorrhizal roots absorb more phosphorus and possibly other minerals than nonmycorrhizal roots. The fungus Trichoderma lignorum (Tode) Harz was shown not only to be parasitic on species of Phytophthora but also to produce an antibiotic that inhibits the growth of those root parasites (8).

The severity of attack by P. parasitica may be influenced by the virulence of the isolate. Virulence differs among cultures of P. parasitica collected in Florida (6).

Low budding, deep planting, and cold protection measures such as soil banking and tree wraps increase foot rot incidence by bringing the pathogen in contact with the scion portion of the stem and by keeping the bark surface moist, thereby favoring fungal penetration (13). Phytophthora can penetrate nonwounded green bark and young feeder roots directly. It cannot infect hardened, gray bark on tree trunks directly and requires a wound or growth crack for penetration of these tissues (5). The soil line should correspond to the top of the first main lateral roots. Cultivation injuries and overwatering of trees favor infection. Good cultural practices in combination with proper nutrition encourage healthy root development and improve tree vigor. Trees under stress are predisposed to infection.

The use of resistant rootstocks offers an excellent means of reducing the losses from root rot and foot rot. Resistance to Phytophthora means that the feeder roots and the crown roots do not become heavily infected with Phytophthora. Scion resistance to Phytophthora means that even when Phytophthora zoospores are splashed from the soil onto the scion, characteristic foot rot symptoms of gumming, extensive lesion development and trunk girdling do not occur (5). Trifoliate orange varieties and their hybrids, Citrus macrophylla Wester and sour orange, possess a high degree of resistance (1,2,5,7,9,14). Sweet orange varieties are susceptible (1,5,7,9).

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